Highlighting Coral Reefs in Coastal Planning and Management in Sabah, Malaysia
Project Goal and Objectives:
The goal of the project was to improve coastal management in Sabah, Malaysia, particularly with regard to halting degradation of coral reefs. The overarching method of the project was to use the tools, techniques and data developed under the *Reefs at Risk in Southeast Asia* project to implement more detailed analyses of threats to coastal resources in Sabah in close collaboration with local partners. Another key aspect of the project was dissemination of results in order to raise awareness of other government officials and the public and improve management of coral reefs.

The project was implemented in close collaboration with the Town and Regional Planning Department (TRPD) in Sabah, Malaysia, the Borneo Marine Research Institute of the University Malaysia Sabah (UMS/BMRI) and an eleven-agency Integrated Coastal Zone Management (ICZM) working group.

Five specific project objectives were identified in the project document:

a) Ground-truth and improve the quality of the coral reef data set for Sabah;

b) Facilitate the transfer of additional information on coral reefs, coastal resources, and fisheries to the TRPD;

c) Improve the mapping of destructive fishing activities in Sabah’s waters;

d) Implement an analysis of coastal development and upland landuse development scenarios and implications for coral reefs. These results will be used by the Planning Department in the development of a coastal statutory plan for Sabah;

e) Produce a short summary report on the results of the analysis and distribute this in Sabah.

Outputs:
The project document proposed the following outputs:

1) Improved data on coral reef locations in Sabah;

2) GIS data layers on coral reef locations and estimates of threat to coral reefs from a range of human activities, particularly threats from land-based activities and destructive fishing;

3) A model for threat assessment of coral reefs in Sabah, Malaysia. This model will be developed in collaboration with the TRPD, UMS/BMRI and the ICZM working group, and will be targeted on providing the information required to give due consideration to coral reefs in development of the coastal statutory plan. In addition, this approach is intended to build the capacity necessary to continue to monitor threats to Sabah’s reefs long after the activity is completed;

4) A report summarizing the analysis and findings.

a) Assemble additional data at the Planning Department – During the fall of 2001 and early 2002, TRPD obtained additional data from other agencies in Sabah, and digitized data on coral reefs in support of this project. In March I worked with Colleen Tan of the TRPD to evaluate data, identify the best available data within a given theme, and harmonize these within a common format. Themes ranged from elevation, land cover and watershed boundaries, to population density, road network, and ports. Many of these data sets served as input to the threat modeling.

Accomplishments and Impact:

a) Coral reef location mapping and assessment– Project partners collaborated on the development and assessment of an improved coral reef data set for Sabah. This was done at the TRPD offices, in collaboration with the UMS/BMRI and with Serge Andrefouet of the University of South Florida. We made use of a large number
of aerial photographs (already purchased by UMS/BMRI) and obtained some high resolution satellite imagery from Serge Andrefouet. Using these data, we were able to evaluate and improve two existing coral reef maps. This allowed us to finalize a coral reef data sets in March, 2002, thereby allowing TRPD to transfer coral reef information on to their detailed “planning schemes.” This transfer of data is a labor intensive process and involved significant time commitment by TRPD. But, this act facilitates the consideration of coral reefs in land use planning decisions.

b) **Conduct threat analysis** – Data improvement, and harmonization are preludes to the threat and vulnerability analyses. Most of the threat analysis was implemented at TRPD, in collaboration with staff of the TRPD and UMS/BMRI. The project was successful in evaluating threat from coastal development; coral reef vulnerability to pollution and sedimentation; threat from overfishing; and threat from destructive fishing. These results, as presented in an 18-page atlas and as digital maps and GIS data sets on CD (enclosed), have been provided to TRPD and UMS/BMRI.

c) **Improve the data holdings of the ICZM effort at the Planning Department** – Prior to this project, the ICZM effort had not produced digital data sets for Sabah of any submerged features. The TRPD now has a digital mapping of coral reef locations; has added these locations to their hard copy “planning schemes” and has GIS data sets on mangroves, wetlands, and other coastal land use, in addition to the modeled estimates of areas where coral reefs are vulnerable to coastal development. (See atlas for details of this analysis.)

d) **Include consideration of coral reefs within the coastal statutory plan for Sabah** – TRPD has now submitted text for the revised statutory plan which for the first time includes consideration of coral reefs and explicitly restricts development near coral reefs.

e) **Develop a summary report and share results widely** – The summary of the analysis produced at this time is the 18-page atlas, technical notes, and data CD. The final products of the analysis (GIS data CD and the Coastal Vulnerability Atlas) were produced at WRI.

**Outstanding Issues / Lessons Learned / Continuing Activities**

The project achieved all of its objectives with regard to information development and sharing, and influencing the development of a statutory plan. Although many partners from across the eleven agency ICZM working group shared data and contributed to the project approach, the analysis was implemented primarily with TRPD and UMS/BMRI. Adrian Chong, director of TRPD and Giam Lunkapis, head of the ICZM study, were key advocates for the project, and Collen Chang (TRPD) was an excellent GIS-analyst counterpart, while Annadel Cabanban facilitated most of the meetings and collaboration.

**Project Contacts**

Lauretta Burke (lauretta@wri.org)
World Resources Institute, 10 G Street, NE, Washington, DC 20008 USA Fax: +1 202 729 7775 Phone +1 202 729 7774

Gaim James Lunkapis (gaim@tm.net.my), Colleen Tan (colleen.tan@sabah.gov.my)
Town and Regional Planning Dept. 3rd Floor, Block B, Wisma Tun Faud Stephens, Karamunsing, 88646, Kota Kinabalu, Sabah, Malaysia

Annadel Cabanban annadelc@hotmail.com
University Malaysia Sabah, Borneo Marine Research Institute, Kota Kinabalu, Sabah, Malaysia
Coral reef locations were classified by an estimate of "vulnerability of areas for coral," which is based on depth, embayment, fetch, an area’s proximity to land, and associated land-based sources of pollution. The two coral classes were taken into account in evaluating vulnerability - "Mapped Coral Reefs" were weighted 1.5 times as heavily as areas where "Coral Likely to be Present," to take into account the likely density of coral in the area. This is a 100 meter resolution GRID.

Projection: Brunei
Rectified Skewed Orthomorphic

This analysis of threats to the coral reefs of Sabah is a collaboration of the Town and Regional Planning Department of Sabah, the University of Malaysia Sabah / Borneo Marine Research Institute, and the World Resources Institute.
Coral Reefs Threatened By Coastal Development

Estimated Threat From Coastal Development
- Low
- Medium
- High
- Land Areas
- Territorial Waters of Sabah

Threat from coastal development was estimated based upon a coral reef's proximity to population centers (stratified by size), airports, major roads, ports, pipelines, and tourism centers. Tourism centers include dive centers, golf courses, and large hotels. The vulnerability of the area to pollution and sedimentation was also considered.

Projection: Brunei Rectified Skewed Orthomorphic

This analysis of threats to the coral reefs of Sabah is a collaboration of the Town and Regional Planning Department of Sabah, the University of Malaysia Sabah / Borneo Marine Research Institute, and the World Resources Institute.
Coral Reefs Threatened By Destructive Fishing

Estimated Threat from Destructive Fishing

- Low
- Medium
- High
- Land Areas
- Territorial Waters of Sabah

Estimated threat from destructive fishing is based on the Reefs at Risk in Southeast Asia (RRSEA) analysis (World Resources Institute, 2002). The 1 km resolution threat estimate from RRSEA is based on observed occurrence and expert opinion on the location and extent of blast fishing and fishing with poisons. This estimate was overlaid with revised coral reef locations for Sabah.

Note: These estimates were made before the government of Sabah increased enforcement of regulations prohibiting destructive fishing. This mapping can be revised by UMS/SMRI and Task Force members, if desired.

Projection: Brunei Rectified Skewed Orthomorphic

This analysis of threats to the coral reefs of Sabah is a collaboration of the Town and Regional Planning Department of Sabah, the University of Malaysia Sabah / Borneo Marine Research Institute, and the World Resources Institute.
The relative erosion vulnerability for each 100 meter grid cell was evaluated based upon slope, precipitation for the peak rainfall month, and soil porosity. Areas which are more prone to erosion are on steep slopes, have high precipitation amounts, high precipitation variability, and high soil porosity.
Estimated Sediment Delivery By Watershed

The indicator, "Estimated Sediment Delivery," is a relative indicator, and is therefore unitless. It combines an indicator of erosion within the watershed (relative erosion potential) with an indicator of river discharge (the sum of precipitation within the watershed during the peak rainfall month). Estimated Relative Sediment Delivery is a proxy indicator of relative sediment delivery at the river mouth, given current land use within the watershed.

Projection: Brunei Rectified Skewed Orthomorphic

This analysis of threats to the coral reefs of Sabah is a collaboration of the Town and Regional Planning Department of Sabah, the University of Malaysia Sabah / Borneo Marine Research Institute, and the World Resources Institute.